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Bonca

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[54] **ALL TERRAIN DRILL UNIT**

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[73] Assignee: **BOA Drilling Equipment, Inc.,** Toronto, Canada

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[51] **Int. Cl.**[3] **E21C 11/02**

[52] **U.S. Cl.** **173/23;** 173/27; 173/28

[58] **Field of Search** 173/23, 27, 28

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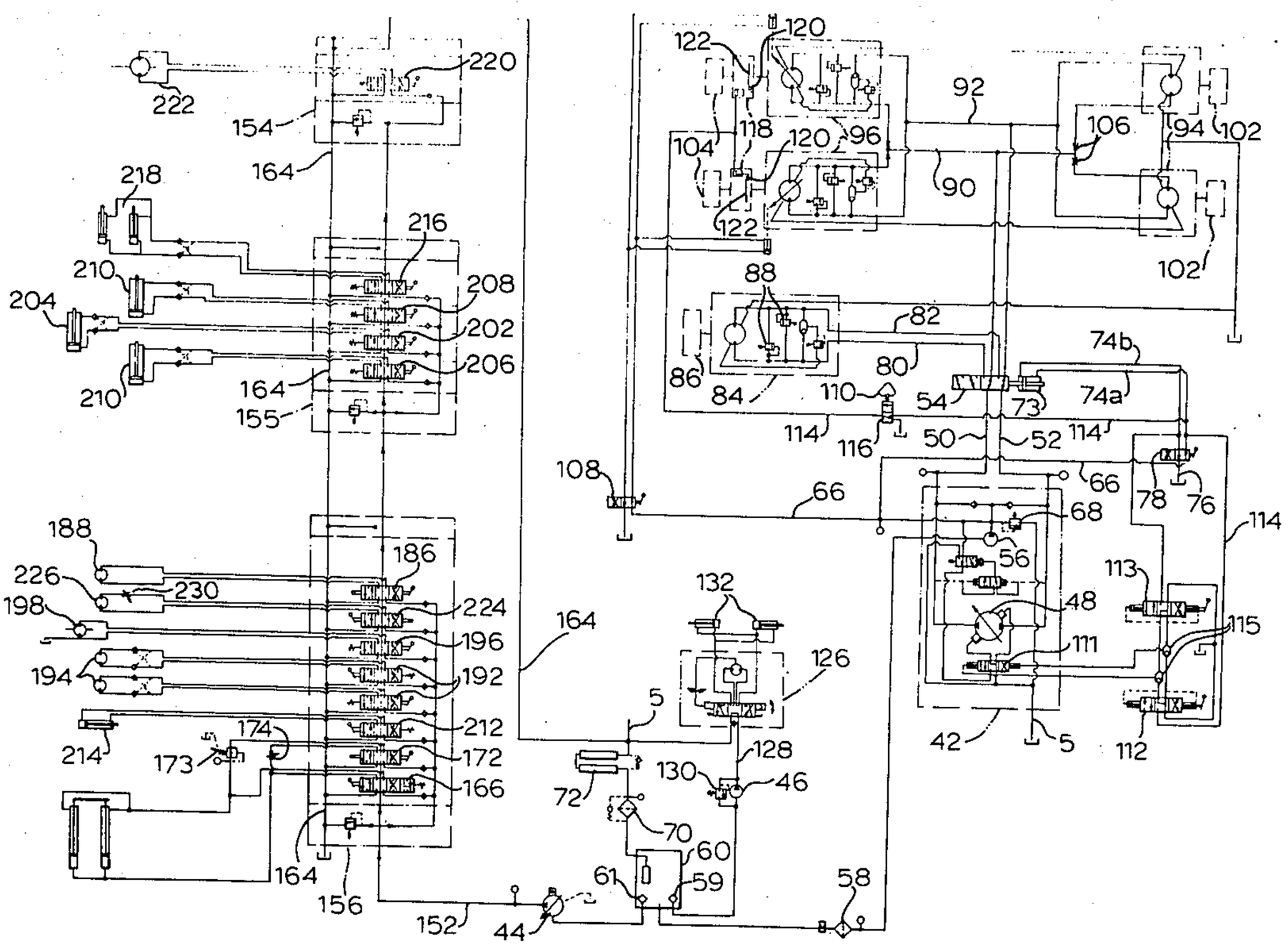
Primary Examiner—Robert Mackey

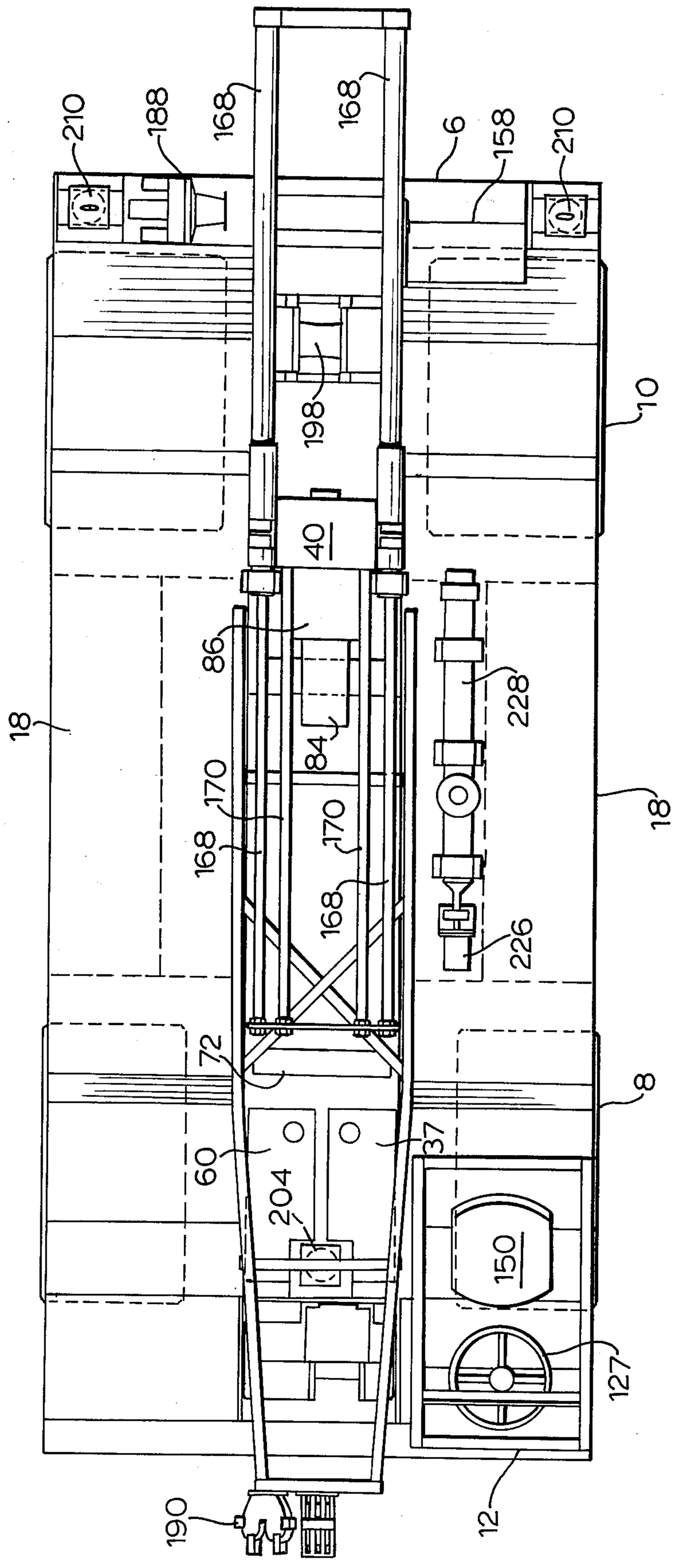
Attorney, Agent, or Firm—Ridout & Maybee

[57] **ABSTRACT**

A self-propelled all terrain drill unit having propulsion means for the chassis, a drilling mast mounted on the latter for movement between horizontal and vertical positions and a drilling head carried by the mast wherein all major functions are performed hydraulically, the hydraulic functions being divided into two groups; those of propelling the vehicle to a drilling site and operating the drill at the site provided by a variable displacement pump and those of adjusting the position of the machine at the site and aligning and positioning the drilling head provided by an independent pump.

6 Claims, 8 Drawing Figures

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188
168
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6
158
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198
10
40
6
86
18
228
84
170
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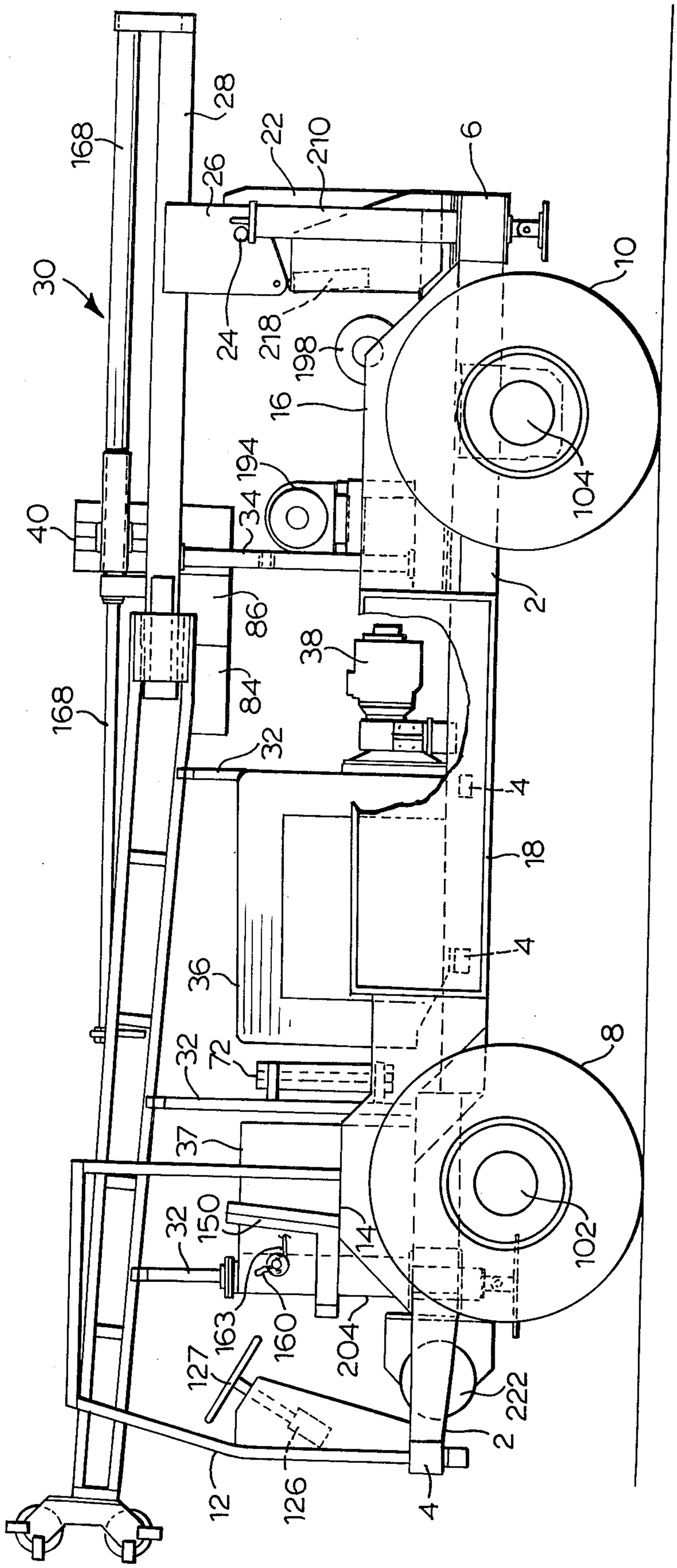
168
168
226
72
18
8
60
37
204
150
127
190
12

FIG.1


168
28
22
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26
6
30
24
218
198
10
16
194
34
104
40
2
86
38
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168
32
4
18
36
4
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102
163
160
204
127
222
2
12
126
4

FIG. 2

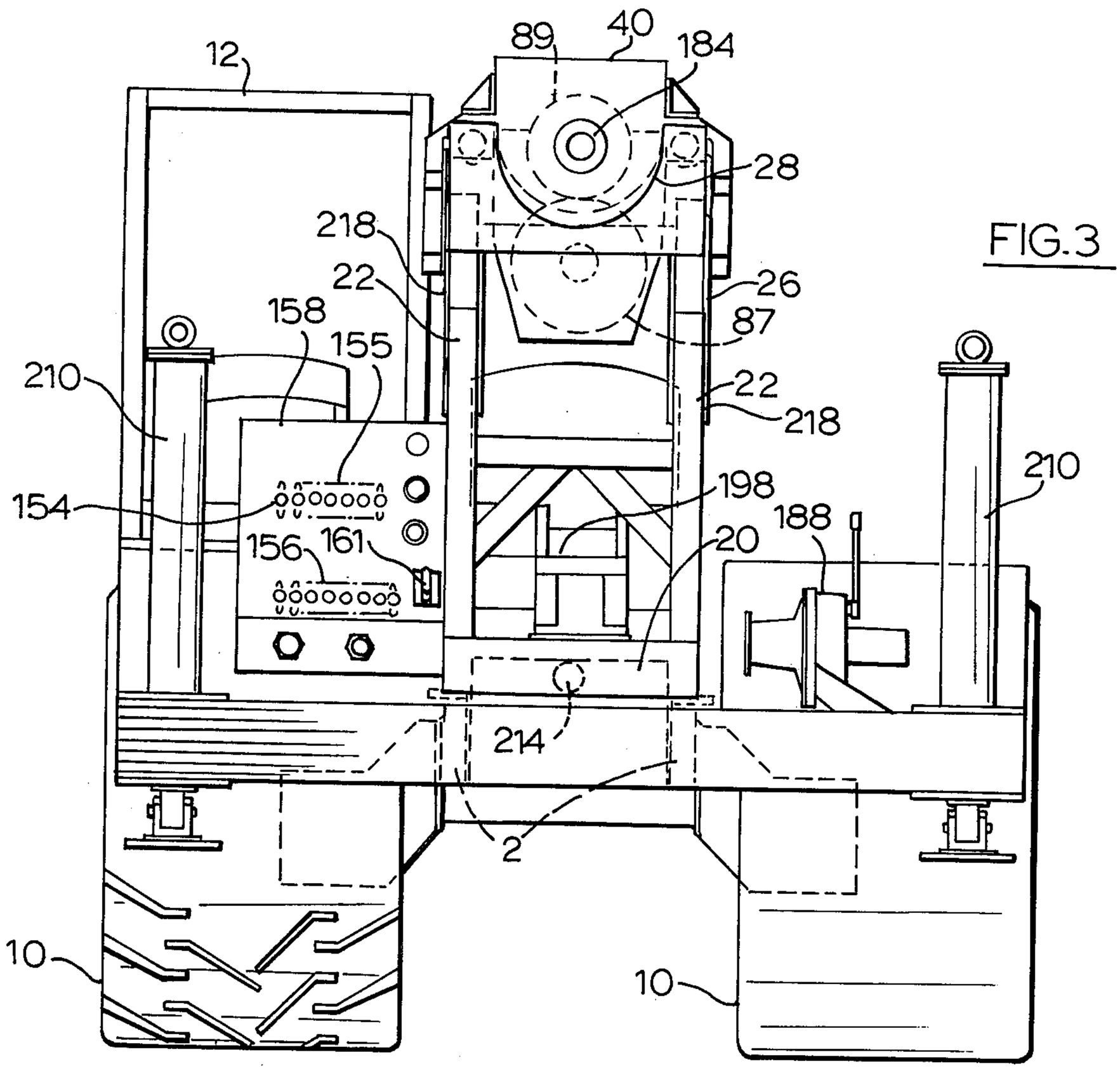

12
89
40
184
28
218
22
158
155
26
87
210
22
218
210
198
154
188
156
161
20
214
2
10
10

FIG.3

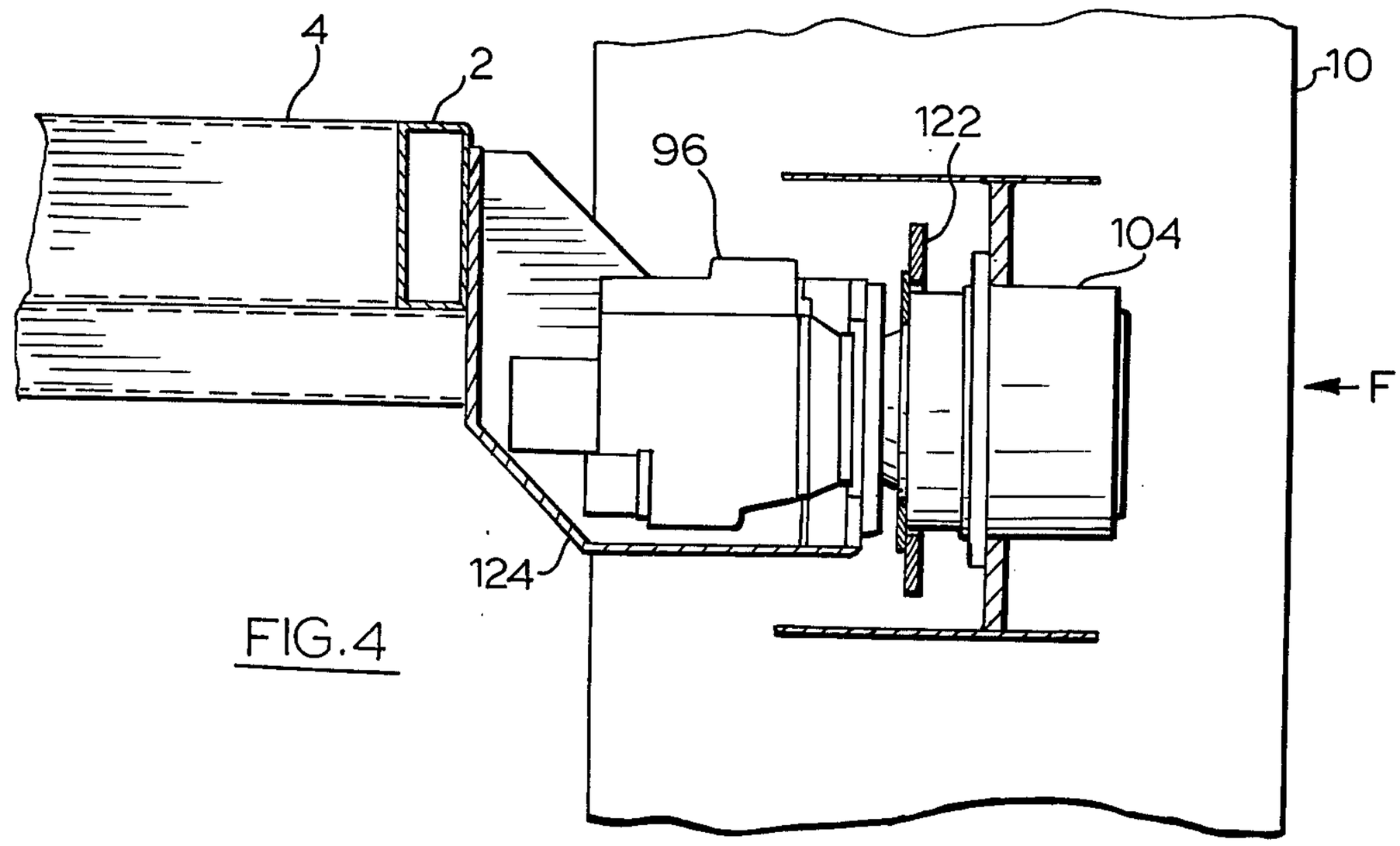

4
2
10
122
96
104
F
124

FIG.4

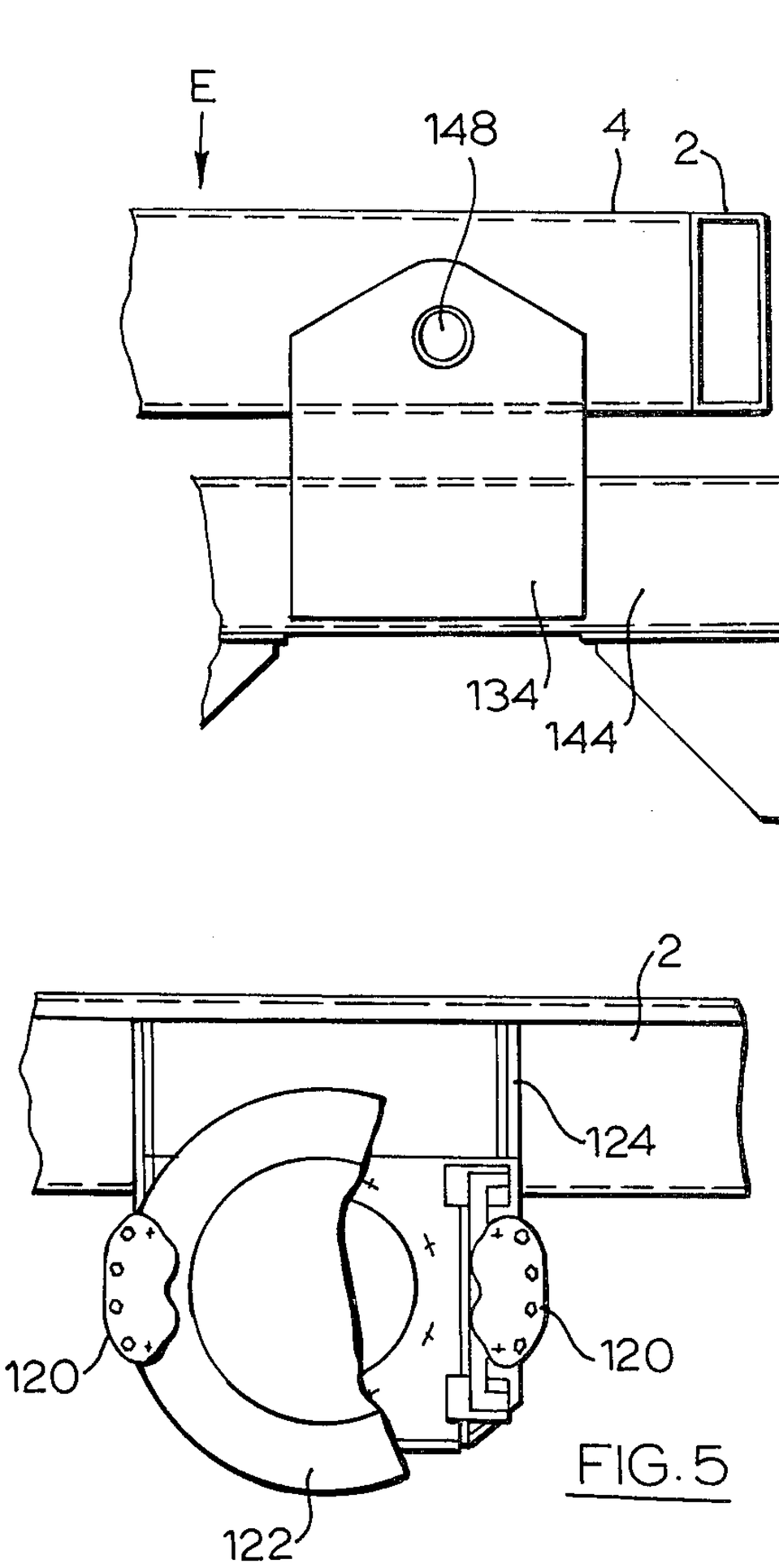


FIG. 5

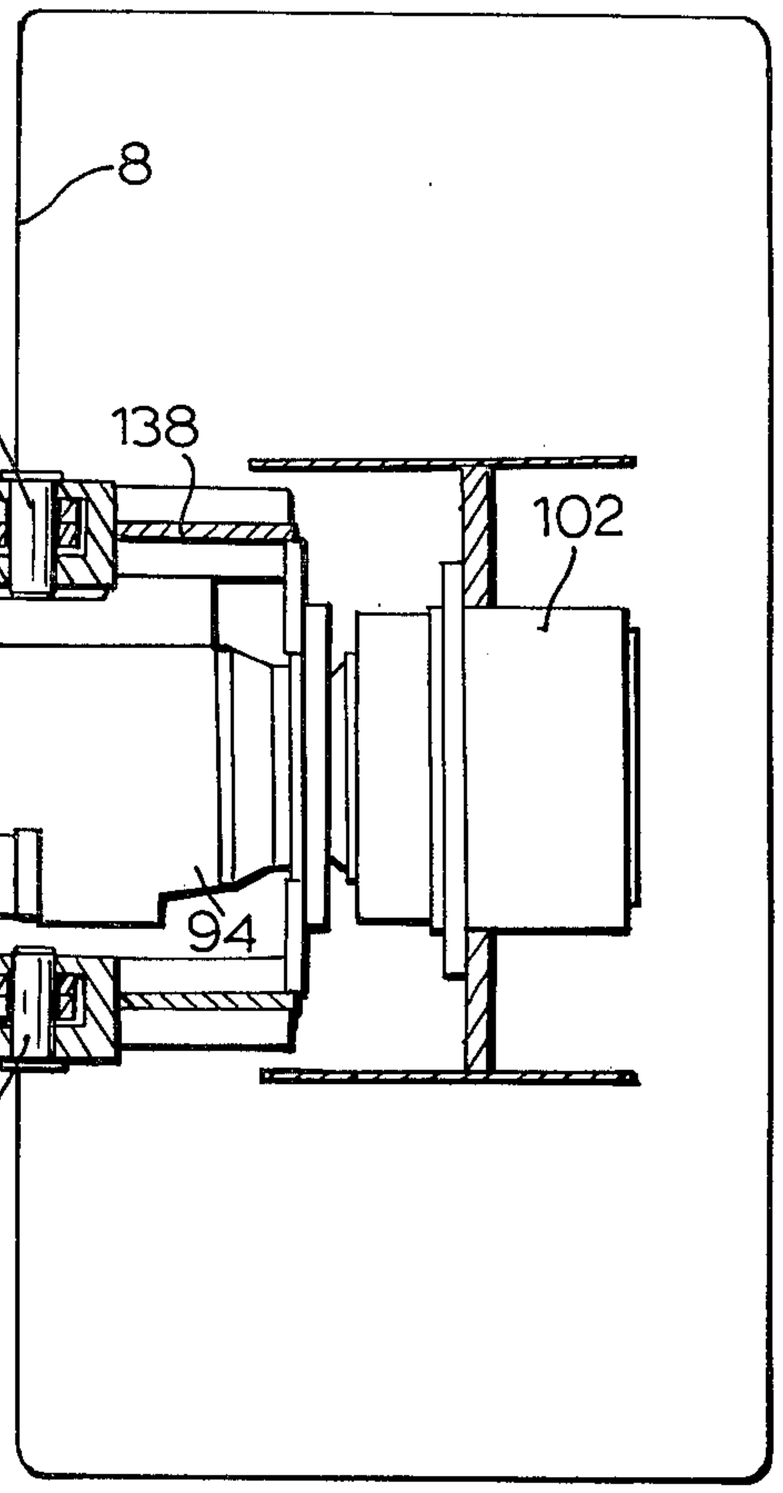


FIG 6

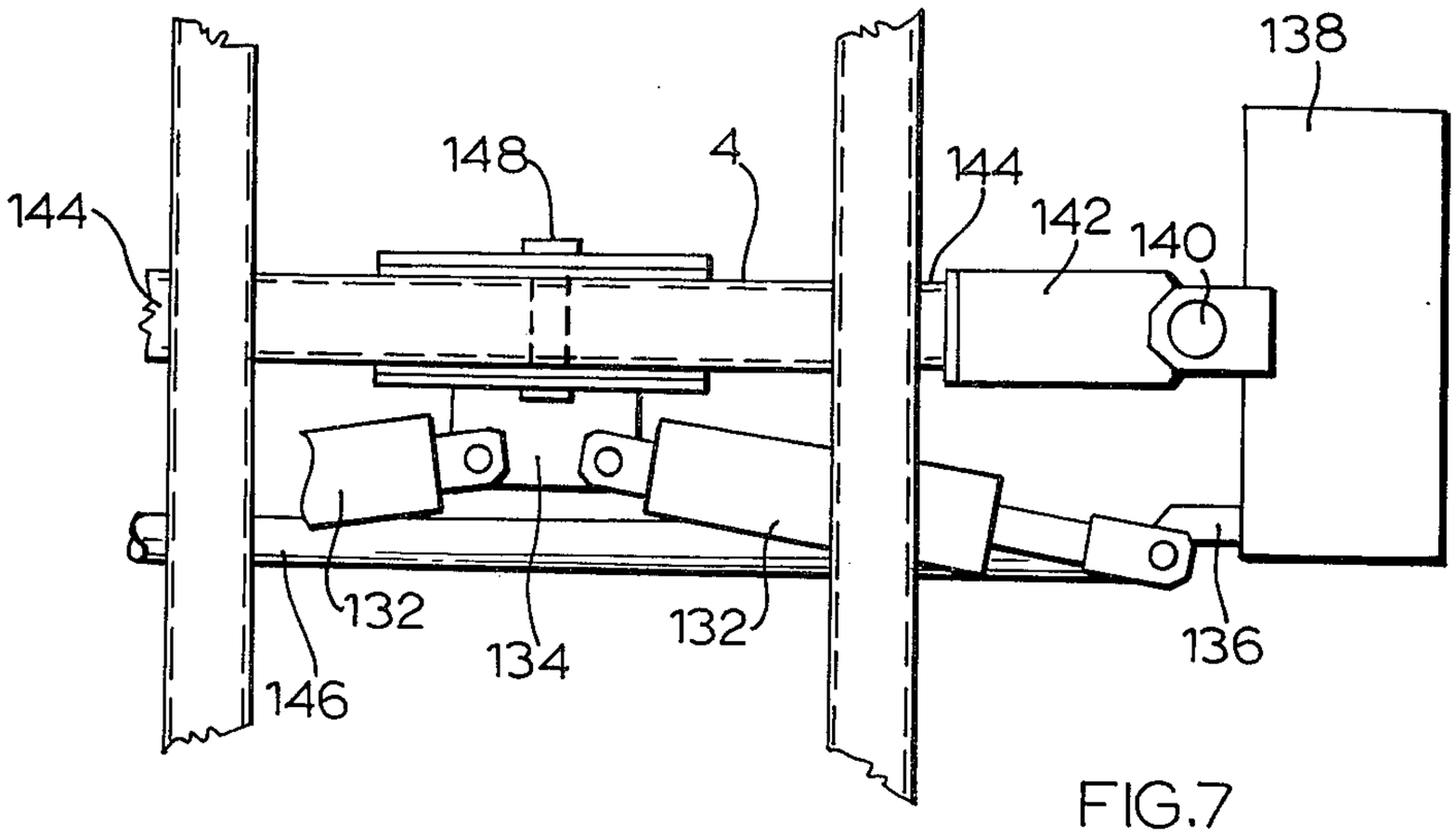
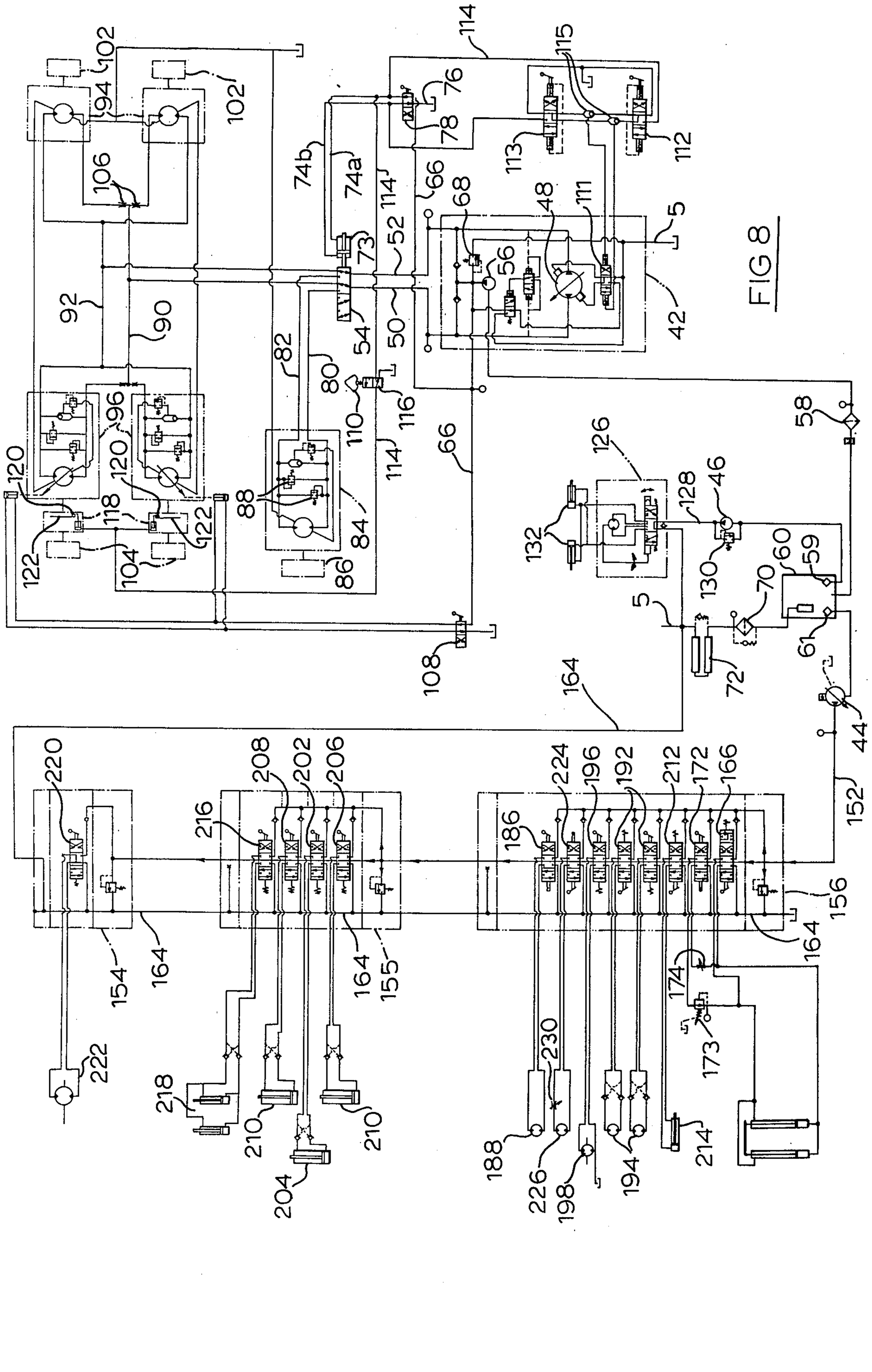


FIG. 7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94
102
106
114
115
76
78
74b
74a
114
66
68
48
111
113
112
52
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56
42
92
90
82
80
54
50
110
116
114
66
120
120
96
88
84
118
122
122
104
86
126
58
128
46
132
130
60
59
70
5
61
108
72
44
164
152
220
208
202
206
216
186
224
196
192
212
172
166
156
164
154
164
164
155
174
222
218
210
210
204
188
230
226
198
194
214
173

FIG 8

ALL TERRAIN DRILL UNIT

FIELD OF THE INVENTION

This invention relates to an all terrain drill unit of the kind comprising an all terrain vehicle chassis carrying a drilling mast which may be moved between a horizontal position overlying the chassis and a vertical position at one end of the chassis, the vehicle chassis being used to bring the drill to a desired location and also carrying a power source for the drill.

BACKGROUND OF THE INVENTION

In conventional units of this kind, it has been known to carry out various of the vehicle functions using hydraulic motors or actuators, but the relatively high cost of such techniques has restricted their use to selected functions only. We have found however that the advantages gained by using hydrostatic drives for essentially all of the vehicle functions outweigh the extra cost involved, particularly in the respect that with proper application of conventional hydrostatic engineering techniques, we find that a more versatile and effective unit can be produced which is nevertheless substantially easier to operate than conventional units.

SUMMARY OF THE INVENTION

As compared with conventional units, a drill unit in accordance with the invention, in which all major functions are performed hydraulically, and in which the controls for these functions are appropriately integrated and interlocked, can have the advantages of being able to drill at any angle to the vertical (available conventional mobile drills of this type can only drill vertically), of being exceptionally simple to operate (most conventional units require extensive operator training), and reliability and easy maintenance in that all of the major drive parts may be readily available standard items. To this end, hydraulic drive units are used both to provide traction for the vehicle chassis and drive for the drilling unit; the use of a hydraulic drive in the drilling head eliminates the need for the mechanical drive conventionally used for this purpose and enables the drilling head to be operated at any angle to the vertical at full efficiency.

Moreover, the use of hydraulic operation enables exceptionally simple controls to be utilized. In accordance with a further feature of the invention, a single pump controlled by a lever with a central neutral position is preferably utilized to determine the rate of forward and reverse movement of the vehicle in accordance with the degree of forward or rearward movement of the lever which is connected to appropriate proportioning valves in hydraulic circuits of the vehicle. By means of another control, the output of this pump may be switched so that instead of determining forward and reverse movement of the vehicle, it determines forward or reverse rotation of the drill. In a preferred arrangement, the control lever is duplicated both in a driving cab of the vehicle to control movement of the vehicle and at a control console adjacent the drilling head at the rear end of the vehicle to control rotation of the drill.

In accordance with a further preferred feature, and in order to allow for the different drilling speed ranges required for different types of drilling operation, the hydraulic drive to the drilling head incorporates a change speed gearbox which may have a hydraulically

controlled shift. Preferably the gears are selected by two position selectors which are both normally centered in a neutral position by springs and displaced into gear selecting positions by independently controlled hydraulic cylinders so that the selectors may be operated in any desired combination.

According to a further preferred feature of the invention, each wheel of the vehicle is driven by an independent hydraulic motor, and a flow limiting valve is provided in the supply line to each hydraulic motor so that in the event of any wheel slipping or lifting clear of the ground, power will still be available at the other wheels, and the slipping wheel will not spin uncontrollably and thus worsen the lack of adhesion. Drive power may be applied either to the wheels of only one axle, or to all four wheels; the application of drive to all four wheels may be achieved by hydraulically controlling variable capacity drive motors on two of the wheels to change between idling and powered states.

The drilling mast is preferably pivotally mounted on a sub-frame which may be moved horizontally by hydraulic actuating means to provide exact positioning of the drill. The vehicle chassis is preferably further equipped with three hydraulically extensible legs whereby, on reaching a desired drilling station, it may be anchored firmly on the ground and appropriately levelled. The drilling mast, as well as hydraulic drive means for drill bits and hydraulic means for advancing the drive means relative to the mast as drilling proceeds, may also have associated with it hydraulic winches operating conventional block and tackle means for handling drill bits, corers and the like.

Preferably, the drill head itself comprises a hydrostatic motor, a change speed gearbox, and a reduction gear drive to an output shaft through which the drilling torque is applied. Although contrary to normal practice, the use of geared drive throughout instead of the more usual chain drive has the advantage of providing a compact assembly in which adequate thrust bearings may readily be applied to the output shaft. It is found in practice that the drilling heads of such drill units are subjected to considerable abuse, and the compact assembly which can be provided by a geared drive can more easily be engineered to withstand the abnormal stresses to which the head may be subjected when used for purposes which it was not intended.

Further features and details of the invention will be apparent from the following description of a preferred embodiment of the invention.

SHORT DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of the drilling unit,

FIG. **2** is a side elevation of the unit,

FIG. **3** is a rear elevation of the unit,

FIG. **4** is a fragmentary vertical section on the centre line of a rear wheel of a vehicle chassis of the unit,

FIG. **5** is a view from the direction of the arrow F in FIG. **4**, with the wheel and parts of the wheel hub removed for the sake of clarity,

FIG. **6** is a fragmentary vertical section on the centre line of a front wheel of the vehicle chassis,

FIG. **7** is a fragmentary plan view from the direction of the arrow E in FIG. **6**,

FIG. **8** is a schematic diagram of the hydraulic circuits of the unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. **1** to **3**, the drill unit is built upon a ladder-type chassis comprising longitudinal members **2** and cross members **4** and **6**, supported on front and rear wheels **8** and **10**. Outrigger portions of the cross members **4** and **6** support a cab **12**, fenders **14** and **16** and lockers **18** for carrying drills and other accessories. Guided for longitudinal motion relative to the rear of the chassis upon a bed formed by the longitudinal members **2** is a subframe **20** having uprights **22** which support, through pivots **24**, brackets **26** attached to a cradle **28** forming part of a drilling mast indicated generally by the reference **30**. The mast is normally supported in a horizontal position over the chassis by additional rests **32** and **34** carried by the chassis.

Also carried on the chassis frame is a prime mover in the form of an internal combustion engine **36** supplied with fuel from a tank **37** and coupled to several hydraulic pumps, these pumps being shown generally as an assembly **38**.

The various functions of the drilling unit are best described in conjunction with their associated hydraulic circuits, as shown in FIG. **8**. A primary hydraulic circuit, providing motive power for the vehicle chassis of the unit and for a drilling head **40** carried by the mast **30** is shown on the right hand side of FIG. **8** and comprises a variable displacement pump unit **42** forming part of the assembly **38**. A secondary hydraulic circuit supplied by a constant displacement pump **44** incorporated in the assembly **38** comprises all of the auxiliary functions associated with the drilling function of the rig. These various auxiliary functions will be described further below. An auxiliary pump **46** is provided for use during movement of the vehicle to provide the steering function.

Referring now in more detail to FIG. **8**, the pump unit **42** includes a variable displacement pump **48** having output lines **50** and **52** and receiving input oil from a return line **5**. In order to provide various control functions described below, an auxiliary pump **56** is provided drawing oil through a filter **58** from a tank **60** (see also FIGS. **1** and **2**). The various sumps shown in the diagram are all returned to this tank **60** via an oil cooler **72** (see FIGS. **1** and **2**) and a return line filter **70**. The output pressure from pump **56** on the line **66** is controlled by means of a relief valve **68**. Other details of the pump unit, apart from the control functions discussed below, need not be described in detail since the unit shown is a conventional proprietary item (Eaton transmission pump No. 5420-024).

The lines **50** and **52** are connected to a change-over valve **54** operated by a double acting actuator **73**. The control pressure for the actuator **73** is applied through two control lines **74***a* and **74***b* either to the line **66** or to a return line **76** by means of a manually operated changeover valve **78**. When the pressure from line **66** is applied to the line **74***b*, the valve **54** is moved to the opposite position from that shown, and the lines **50** and **52** are connected by lines **80** and **82** to a constant volume hydraulic motor unit **84**, which drives the drill head **40** through a gearbox **86** and reduction gears **87** and **89**. Overloads on the gearbox and motor transferred back from the drill head are prevented by back-to-back pressure relief valves **88**.

When pressure from the line **66** is applied to the line **74***a*, the valve **54** assumes the position shown, thus connecting the lines **50** and **52** to fixed volume hydraulic motors **94** and variable volume hydraulic motors **96** through lines **90** and **92**. The motors **94** drive the front wheels **8** through reduction hubs **102**, and the motors **96** drive the rear wheels **10** through reduction hubs **104** (see FIGS. **4** and **5**). A manually operated changeover valve **108** connected to the line **66** controls double acting actuators operating the flow controls on the motors **96** so as to move these between neutral and full flow, so as to provide either two or four wheel drive. The maximum flow of oil to the motors **94**, **96** driving the individual wheels is limited by flow restrictors **106**. In the event of one driven wheel losing adhesion, the presence of the flow restrictor **106** associated with that wheel prevents its associated motor from hogging the entire oil supply, and ensures that traction is maintained on the other wheel or wheels. Obviously, the relative calibrations of the various restrictors may be varied should it be desired to redistribute the maximum oil flows permitted to each wheel.

The line **66** also supplies, via the valve **78** and line **114**, a brake valve **116** by means of which hydraulic pressure may be applied to or released from cylinders **118** operative to release normally applied disc brakes **120** (see FIG. **5**) acting on brake discs **122** attached to the hubs **104** (see FIGS. **4** and **5**) As will be seen from FIGS. **4** and **5**, the hubs **104** and motors **96** for the rear wheels **10** are supported by brackets **124** on the longitudinal members **2** of the chassis. Since pressure is applied via the valve **78**, the brakes can only be released when this valve is positioned so that the valve **54** applies fluid pressure to the wheel motors **94**, **96**.

The valve **116** is actuated by a cam **110** having a center dwell and ganged with a two way proportioning valve **112** which also has pressure applied thereto via the valve **78** and the line **114**. The arrangement is such that the valve **116** is closed when the proportioning valve is closed, and open when the proportioning valve is opened in either direction. The proportioning valve acts upon opening so as to move a control valve **111** in the pump unit **42** proportionately in a corresponding direction so as in turn to set up a proportionate pressure differential between the lines **50**, **52**, the sense of the differential being in accordance with the direction of opening of the valve **112**. Hence movement of the valve **112** out of its closed position releases the brakes **120** and progressively applies power to the vehicle wheels so as to drive the vehicle in either direction according to the direction of movement of the valve.

When the valve **78** is reversed, control pressure is applied to a two way proportioning valve **113** ganged with the valve **112**, which then operates in the same way as the valve **112** to apply the variable and reversible differential output from the pump **48** to the drill head motor **84**. Two way check valves **115** act to isolate that one of the valves **112**, **113** to which pressure is not applied.

Referring now to the lower center portion of FIG. **8**, the pump **46** draws oil from the tank **60** through a filter **59**, and delivers it to a steering control unit **126** (see also FIG. **2**) through a line **128** in which the pressure is controlled by a relief valve **130**. The steering control unit **126** is conventional, and selectively supplies oil to two steering actuators **132** (see FIG. **7**). Referring to FIGS. **6** and **7**, the actuators **132** act between a bracket **134** and steering knuckles **136** welded to the sides of cylindrical drums **138** which house the motors **94**. Diametrically opposite points at the top and bottom of the

drums are connected by king pins **140** and forks **142** to a front axle **144** to the center point of which the bracket **134** is attached. The knuckles **136** are connected by a tie rod **146** so as to complete an Ackerman steering linkage, and the bracket **134** is pivotally connected to a cross member **4** of the chassis by a pivot pin **148** so as to permit the axle to rock laterally relative to the chassis. Since the rear wheels are fixed relative to the chassis, this enables the front axle to move to accommodate unevenness in the terrain without influencing the steering. The steering unit **126** is connected to a steering wheel **127** appropriately positioned relative to a driver's seat **150** in the cab **12**, and an appropriate feedback connection is established between the front wheels and the steering unit **126** to control the pressure applied to the cylinders **132**.

Referring now to the left hand portion of FIG. **8**, the pump **44** draws oil from the tank **60** through a filter **61**, and supplies pressurized oil via the line **152** to the various auxiliary functions associated with operation of the unit in its drilling mode. Oil from the line **152** is applied to the various auxiliaries by means of valves assembled into banks **154**, **155** and **156**. These valve bank assemblies are mounted on a control panel **158** at the rear of the vehicle chassis adjacent the operating position of the drilling mast **30**. The control panel **158** also carries a lever **161** operating the valves **112** and **113** for the variable volume pump unit **42** via a cable, a further lever **160** also operating the valves **112** and **113** via a cable **163** being provided in the cab **12**. The control function is such that in the mid position of the control levers **160**, **161**, the output pressure from the pump **48** is the same on both lines **50** and **52**, and movement in opposite directions from the central position produces a pressure differential between the two lines in a sense depending on the direction of movement of the lever. The valve **78**, determines whether the levers **160**, **161** control the drill head **40** or the motors **94**, **96**.

All the auxiliary functions save the water pump referred to below are powered by double acting linear hydraulic actuators or reversible hydraulic motors. The individual valves in the banks **154**, **155** and **156** each have three positions, a first position in which one output line is connected to the line **152** and the other line to a return line **164**, an intermediate position in which both output lines are either blocked, and a third position in which the one line is connected to the line **164** and the other line to the line **152**.

The valves in the bank **156** control various functions mainly associated with the operation of the drilling head **40**. A valve **166** controls two actuators **168** which move the head **40** longitudinally of the mast **30** on guides **170** (see FIGS. **1** and **2**). A second valve **172** is connected in parallel with the valve **166** but is in series with a flow restrictor **174** and a relief valve **173**; the valve **172** may be used when it is desired to move the drill head at a lower rate, as during actual drilling, whilst the valve **173** limits the thrust applied to the drill. A fourth position of the valve **166** allows the actuators to permit the drill head to move downwards under gravity, but not in the opposite direction.

Valves may be provided to control double acting cylinders which operate the selectors in the change speed gearbox **86** so as to alter the ratio of the gearing between the motor **84** and the output shaft **184** of the drill head **40**, or these selectors may be operated manually.

The valve **186** controls a cat head winch **188** mounted on the cross member **6**, which is used in conjunction with a cat head **190** in the fitting and removal of drill bits and the like in and from the drilling head **40**.

Two valves **192** control two boom winches **194**, and a valve **196** controls a further winch **198** on the carriage **20**. All of these three winches are used in connection with the handling of drill bits, tubes, corers and the like in association with the drilling mast.

Considering now valves comprised by the valve bank **155**, the valve **202** controls a levelling jack **204** at the front of the vehicle, whilst valves **206** and **208** control levelling jacks **210** at the rear of the vehicle and extending through the cross member **6**.

A valve **212** in the bank **156** controls an actuator **214** controlling longitudinal movement of the carriage **20**, and a valve **216** controls two actuators **218** acting between the platform **20** and the bracket **26** so as to tilt the mast **30** to any desired angle.

The valve **220** in the bank **154** controls an additional winch **222** at the front of the vehicle, and the valve **224** in the bank **156** controls a hydraulic motor **226** driving a water pump **228** used either to supply water for use during a drilling operation, or for extracting excess water as necessary. A variable restrictor valve **230** is provided in series with the pump motor so as to control the pump output.

In use, the drilling unit is driven to a drilling site in the condition shown in FIGS. **1** to **3**, that is with the drilling mast resting horizonally on the supports **32**. The valve **78** is positioned so that the output of the pump **48** is applied to the wheel motors, the valve **108**, which is located in the cab, being positioned either so as to cause the rear wheel motors **96** to idle, or to cause both the motors **96** and the front wheel motors **94** to be powered if four wheel drive is required by terrain conditions. The velocity of the vehicle is controlled by the lever **160** in the cab, which is disposed so that forward movement of the lever causes the vehicle to move forward at a rate dependent on the degree of movement of the lever, and rearward movement causes the vehicle to move rearward according to the degree of rearward movement of the lever. Any additional braking effort which may be required to bring the vehicle to a halt is automatically applied by the brakes **120** when the pressure in the brake cylinders is released by the valve **116** as the lever **160** is returned to its center position. Thus the brakes cannot be released unless the vehicle is powered. On arrival at the site, the vehicle is manoeuvered, using either the lever **160** or the lever **161**, as is convenient, so that the rear of the mast **30** is in line with the desired point of entry of the drilling to be made, and the operator then reverses the valve **78**. The levelling jacks **204** and **210** are extended so as to support the vehicle firmly on the ground and level the chassis, using the appropriate control valves in the bank **155**, and the control valve **216** is used to extend the actuators **218** to whatever extent is necessary to bring the mast **30** to a desired drilling angle. This will normally be vertical, with the cradle at **28** adjacent the supports **22**, but it is an important advantage of the unit that other angles may equally readily be employed if desired. When the required angle has been reached, the mast is locked in position by returning the valve to its intermediate, locked position. Drill bits and the like, according to the operation being carried out, may be fitted to the drill head **40** using the various winches **188**, **194** and **198**, and an appropriate ratio selected in the change speed gear-

box **86** by use of selectors. The lever **161** may then be used to control clockwise and anti-clockwise rotation of the drill shaft **184** in a similar manner to that described with reference to the forward and rearward movement of the vehicle, the valve **78** having previously been operated so as to connect the pump **48** to the motor unit **84**. The drill may be advanced to a drilling position by means of the valve **166**, and precisely positioned over the required point of entry by using the valve **212** to control the actuator **214** moving the carriage **20**. During drilling, the drill may be advanced by the actuators **168** under the control of the valve **172**, or by gravity under the control of the valve **166** in its fourth position. When it is required to change or extend a drill or the like, the drill head may be withdrawn up the mast by the actuators **168** under control of the valve **166**, and the necessary exchange of bits or insertion of extensions handled using the various winches. Any necessary supply or removal of water or mud during the drilling operation can be carried out using the pump **228**.

On completion of the drilling operation, the drills and the like may be stowed in the lockers **18**, the platform **20** retracted, and the drilling mast returned to its horizontal position, the jacks **204** and **210** retracted, and the valve **78** again reversed so that pressurized oil is available for supply to the wheel motors so that the unit may be moved to another drilling site or returned to base. The winch **222** may be utilized if necessary to assist in crossing particularly difficult terrain, or in clearing sites prior to drilling.

What I claim is:

1. In an all terrain drill unit comprising an all terrain vehicle chassis, propulsion means for said chassis, a drilling mast mounted on the chassis for movement between a horizontal position overlying the chassis and a vertical position overhanging the chassis, a drilling head carried by the drilling mast, and a power source on the chassis for the drilling head, the improvement wherein first hydraulically operated actuator means is provided linked to the drilling mast and chassis for moving the former to any location between its horizontal and vertical positions inclusive, second hydraulically operated actuator means is provided linked to the drilling mast and the drilling head for moving the latter longitudinally of the mast, third hydraulically operated actuator means is provided on the vehicle chassis to locate the latter in a desired drilling attitude, and a first hydraulic pump is fluid linked to said actuator means to supply pressurized hydraulic fluid thereto, wherein the power source for the drilling head is a second variable displacement hydraulic pump which is alternatively a power source for the propulsion means for the vehicle chassis and is controllable independently of said first hydraulic pump, wherein the actuator unit for said drilling head is a reversible drive motor and the propulsion means for said vehicle chassis are a plurality of wheels each associated with a reversible hydraulic drive motor, and wherein control valve means are provided through which the second hydraulic pump is selectively fluid linked to said motors for said drilling head and said vehicle chassis, said control valve means comprising a first control valve means adapted to reverse said motors and having a neutral position, and second control valve means directing fluid either to said drill head motor or to said wheel drive motors.

2. A unit according to claim **1**, wherein the drilling head further comprises a change-speed gearbox receiving an input from the drive motor, and a reduction gear drive applying the output of the gearbox to an output shaft, the drive being transmitted from the motor to the output shaft through directly meshing gear wheels.

3. A drill unit according to claim **1** or **2**, wherein the unit has a driving cab on said chassis and a control unit on said chassis adjacent said drilling head and remote from the driving cab, and said first pump and said first control valve means have manual control means duplicated in said cab and at said control unit.

4. A unit according to claim **1**, wherein a flow limiting valve is included in a hydraulic supply line from the control valve means to each wheel drive motor.

5. A unit according to claim **4**, wherein the motors associated with certain of said wheels are variable capacity motors, whereby the torque applied to said certain wheels may be changed relative to the torque applied to the remainder of said wheels.

6. A unit according to claim **1** or **2**, wherein the drilling mast is mounted on a sub-frame, and hydraulically operated actuator means, fluid linked to said first hydraulic pump, is provided between the chassis and subframe whereby to control the position of the latter on the chassis.

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